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IDENTIFICATION OF PHYSIOLOGIC RACES
OF PUCCINIA GRAMINIS TRITICI 1/

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The last key for identifying physiologic races of Puccinia graminis tritici was issued January 1, 1938. It listed 162 races; the present key includes 189, as of January 1, 1944. The list easily could be expanded to more than 200 if minor but consistent characters were used for differentiation between races.

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The Concept of Races and Biotypes

It is becoming increasingly evident that the biotype must be used as a basis for concepts regarding races. Although it is known that there are many biotypes, it would be impracticable to attempt to distinguish all of them as it would be necessary in many cases to compare closely related ones repeatedly, side by side, in order to distinguish between them. As determination of races is made in different places and at different times in the same place, there may be considerable variation in the infection types produced by a single biotype. Likewise, the effects of different environmental conditions may obscure minor differences between closely related biotypes. Therefore it seems best to group very closely related biotypes under the same race and recognize races only on the basis of major differences.

There appear to be almost imperceptible differences between some biotypes and perfectly obvious and consistent differences between others. For example, Reliance is considered immune from races 17 and 49; when inoculated with most isolates of these races, there is no externally visible effect. Occasional isolates, however, produce pronounced necrotic flecks. There is a somewhat greater difference between biotypes of race 59; they are essentially alike on all the differentials except Marquis, Reliance, and Kota, on which they differ as follows:

	<u>Marquis</u>	<u>Reliance</u>	<u>Kota</u>
Race 59	2	0	0;
Race 59A	2	2	0;
Race 59B	2+	2	2

In the key (table 3), race 59 is found as follows: Little Club, susceptible; Marquis, resistant; Reliance, resistant; Kota, resistant; Arnautka, resistant; Kubanka, mesothetic; Acme, susceptible; Einkorn, susceptible. As only three major classes of rust reactions are used, all three biotypes satisfy the requirements, and it seems best to consider them as belonging to the same race, which, then, produces infection types on Reliance and Kota ranging from 0 to 2.

Race 15 comprises two or more distinct biotypes also. All of the differentials except Khapli are susceptible, but there are different degrees of susceptibility. The infection types given in table 4 are an average of the types produced by many isolates over a period of years in the United States. Later, however, an isolate from Japan proved less virulent than most of those from the United States. It was tentatively called 15A. Then an isolate from Brazil was immediately recognized as being extraordinarily virulent and was therefore designated as 15B. Most of the isolates obtained from collections in the United States during the past several years are of the 15B type.

If the virulence of each race were given a numerical value, generous use of decimals would be necessary to represent slight differences between them. If, instead of mere conventional designations, 17 and 49 represented the virulence of these two races, respectively, as determined by the behavior of those isolates on which the numerical ratings were made originally, biotypes slightly more virulent might properly be designated as 17.1 and 49.1, respectively. Likewise, 59A could be represented by 59.2, and 59B by 59.5. And race 15 would comprise biotypes 14.7, 15, and 15.5.

The use of additional differential wheat varieties in identifying isolates of *P. graminis tritici* probably would reveal biotypes within some races that now seem very homogeneous. As an example, the differences between 15A and 15B are quantitative only. All differentials except Khapli are susceptible to both, but they are more susceptible to 15B. But Rival wheat is resistant to 15A and susceptible to 15B; and yet this is a difference in degree also; the difference between infection type 2 and type 3 or 4. If all infection types caused by all biotypes were seriated, they would range from 0 to 4++ and there would be 27 classes or infection types, without clear class intervals between most of them. The reaction classes recognized in the key--resistant, mesothetic, susceptible--are therefore rather broad classes; but to attempt to subdivide them for the determination of races would only lead to confusion and mistakes without serving a practical purpose.

The Differential Varieties

The differential wheat varieties used in identification of stem rust races are listed in table 1. They were selected almost 25 years ago, as representative of the behavior of a large number of varieties that were tested against the relatively few races discovered up to that time. As new wheat varieties were produced, they too have been tested; but no generally valuable new differentials were found, although some do enable recognition of differences that are not apparent on the standard differentials. Eventually it may be desirable to revise the list, but for the present there seems to be no pressing need for radical change. In any case there never could be complete assurance that an isolate identified as a certain race at a given time and place is genetically identical with another isolate identified at another time and place, unless all known wheat varieties were tested under controlled conditions--which obviously is not practicable.

The present system of identification of races, then, makes it possible to recognize similar but not necessarily identical biotypes or groups of biotypes. In the very nature of things, perfection cannot be attained. There are no type specimens; there are only records for comparing, as an example, the isolates of race 2 in 1943 with those of 1918. And yet those of 1943 fit the record of 1918 perfectly. Likewise, isolates obtained from foreign countries during the past few years often fit perfectly race descriptions made in the United States 20 years previously.

The system used, therefore, seems fairly adequate for comparisons in time and space--for determining geographical distribution and population trends of races. Nevertheless, the conventional determination of races is only a preliminary step in finding out what needs to be known.

To determine the practical importance of rust races at given times and places, it is necessary to determine, under various conditions, the reactions of wheat varieties of the region in question to the races that are prevalent or likely to become prevalent in that region. Naturally, studies should be made on adult plants as well as seedlings.

Obviously, the seed of the differentials should be absolutely pure; otherwise, confusion and sometimes erroneous conclusions are likely to result. In the past it has been difficult to maintain the purity of some varieties, either because of changes in the prevalence of agronomic strains in general or because of mechanical mixtures in the seed lots. As an example, Jenkin is given as an alternative differential. There are several lines of this variety, all of which do not react to rust exactly in the same manner. It has been virtually impossible for a number of years to obtain pure seed lots of Reliance and Kanred. Accordingly, occasional plants react quite differently from the remainder; in most seed lots there have been at least 5 percent of off-type plants. Every attempt should, of course, be made to maintain the purity of the differentials. This is just as important as the use of proper techniques in determining rust races.

Collection and Preservation of Samples

The techniques for collecting and inoculating are rather generally known; accordingly, only a brief summary is given here.

Collection of samples.--It is best to use glassine bags, about $3\frac{1}{2}$ by 7 inches, for field collections. When several successive collections are made on a single trip, care must be taken to avoid contamination. Samples should be taken without touching the rusted portions. When plants are heavily and rather uniformly rusted, the best procedure is to cut several off and insert them part way into the glassine bag, then hold them, with the bag as protection, in one hand while they are cut to the required length with the other. Unless such precautions are taken, inoculum may easily be carried by the collector to contaminate subsequent collections. The open end of the envelope should be folded over only enough to hold the rusted material in place. If sealed too tightly, the material may mold, especially if green and succulent.

Preserving inoculum.--Inoculum will retain its viability for several months if kept at moderate humidity in the dark at a temperature of about 5° C. Fluctuating temperatures should be avoided.

Inoculation Techniques

Growing plants for inoculation.--Plants for inoculation can be grown in 4-inch pots. It is best to sterilize the soil and disinfect the seed to prevent the development of root rots. There should be 15 to 20 properly spaced plants in each pot. It is best to grow these plants in a greenhouse room where no rust material is kept. Plants should be between 2 and 4 inches tall when inoculated.

Incubation chambers.--A convenient chamber consists of three parts: (1) a galvanized-iron pan, 22 inches in diameter and 4 inches deep; (2) a cylinder made of the same material, 1 foot high, with rolled edges, which should fit into the pan easily; (3) a top of glass enclosed in a square wooden frame, which can be placed on top of the cylinder. It is important that the upper rim of the cylinder be even, so that the glass top will cover it tightly and thus promote the development of a fine film of moisture on the plants. An incubating chamber of the above dimensions will hold 12 4-inch pots and thus accommodate a complete set of differentials.

Inoculations.--If field collections contain too little rust to inoculate all differential hosts immediately, spore material is first increased by inoculating Little Club or Jenkin wheat, which are generally susceptible. When there is enough rust in a collection, all differentials are inoculated at the same time. The techniques are as follows:

For small numbers: Rub the leaves gently between moistened fingers, then spray with water, preferably distilled, to wet the plants thoroughly. It is best to use an atomizer for this purpose. Inoculum is removed from the rusted material with a special type of spatula, made by flattening the end of a dentist's explorer tool. Wet the spatula before using, in order to make the spores adhere. Then run the spatula gently over each leaf to be inoculated in such a way as to insure abundant and uniform distribution of spores. Obvious precautions should be taken to cleanse the hands and disinfect the spatula between successive sets of inoculations made with different collections or isolates.

Place the inoculated plants immediately in the pan of an incubation chamber, containing about 1/2 inch of water. Spray the plants gently with water and spray the inside of the cylinder and the cover thoroughly to provide high initial humidity. Put the cover in place and leave the pots in the chamber for 36 to 48 hours, preferably in a cool place, then remove them to the greenhouse bench. Abundant light and a temperature of about 70° F. favor optimum and characteristic development of rust.

When rust pustules appear, cut off with a small pair of scissors all plant parts above the inoculated seedling leaves to facilitate observations.

For large numbers: Rub plants to be inoculated with moistened fingers and place the pots in incubation chambers. Spray the plants

with water to provide a fine film of moisture. Shake rusted material gently over the plants so that spores will drop off and fall on the plants; then brush the rusted material gently over the plants several times to insure adequate and uniform distribution of spores. Again spray gently, to replace moisture which has been brushed off in the inoculating process. Incubate in the usual manner. This method saves labor and provides for random distribution of spores, which is important when more than one race is present in a collection. It increases the danger of contamination, however, and is not recommended for precise work. On the other hand, it is useful when there already is considerable information regarding the races present in a region and when it is merely desired to find out their relative prevalence. Extensive use of check plants indicates that this method is safe if ordinary precautions are taken.

Isolation booths.--To prevent spread of the rust from one series of differentials to others in the greenhouse, partitions of muslin or glass may be set up to form booths for each set of plants. This usually is sufficient to prevent contaminations, but it is a good practice to place non-inoculated check plants in incubators with the inoculated plants often enough to find out whether there is contamination, either from air-borne spores from outside or from rust in the greenhouse.

Use of the Key and Tables (Tables 2, 3, 4)

The key for the identification of rust races is an ordinary trichotomous key. It is necessary to decide only whether varieties are resistant, mesothetic, or susceptible, in order to identify races (table 3).

The principal difficulties are likely to be encountered with infection types 2 and X. The type 2 caused by many races, such as 19 and 59, is quite distinctive and could scarcely be confused with anything else. The type 2 caused by certain biotypes of race 38, however, may sometimes resemble type 3 or even type 4, especially if the inoculated plants are exposed to rather high temperature and high light intensity. It is necessary, therefore, to know the range of type 2 in order to avoid mistakes. The same is true of type X. Under some conditions, and with some races, type X is perfectly distinct, but under exceptionally favorable conditions this type may become X++ and frequently be virtually indistinguishable from a type 4. This may seem somewhat confusing, particularly to those who have not had opportunity to become intimately acquainted with the range of infection types. It is suggested, therefore, that if an isolate does not fit the table, the above facts be kept in mind and attempt be made to find out what the race would be if a somewhat questionable type 4 were type 2. Moreover, if a certain isolate agrees in all particulars with the infection types given for a certain race, except for an X, it would be well to examine the material more closely or to repeat the inoculation.

The infection types given in table 4 are the means derived from averaging the types produced by a number of isolates of the race under a considerable range of conditions. From what has already been said about

closely related biotypes and the effect of environmental conditions, it probably is clear that infection types may fluctuate considerably about the mean.

As previously mentioned, it has been the practice of the writers not to recognize races except on the basis of differences in the major classes, that is, resistant, susceptible, or mesothetic. For example, if the infection type for Reliance for a given race is listed as 0, and an isolate agrees in all respects except that the infection type on this variety is 1 or 2 instead of 0, it is likely that the isolate represents a new biotype, which, however, the writers would be disinclined to consider as a separate race. A good example is race 59. As indicated in the footnote of table 4, there are three clearly recognizable biotypes, but the key does not distinguish between them.

The key and table 4 should be used with the above facts in mind. There often is a considerable range in infection type of a single biotype because of differences in environmental conditions. And some biotypes are so nearly alike that it seems best to consider them as a single race.

Field collections often contain a mixture of races, which can be detected on one or more of the differential varieties. Sometimes it is possible to identify the races even in a mixture because only certain races could cause the particular combination of infection types. For example, races 17 and 19 produce essentially the same infection types on all of the differentials except Marquis. Race 17 produces type 3 or 4 on Marquis, whereas 19 produces type 2. No other combination of known races produces this combination of infection types; consequently, it is possible to identify both races and to estimate the percentage of each in the collection. Identification is not always so easy, however, and it is then necessary to resort to isolations from single pustules of the various types represented.

Mixtures of races usually are most apparent on Marquis, the durums other than Kubanka and Acme, and on Einkorn and Vernal. On Marquis there often are type-2 and type-4 pustules. On the durums, Einkorn, and Vernal there often are type 1 and type 3 or 4. The mixtures are usually quite evident on the durums, and on Einkorn and Vernal, because there is a distinct difference between the infection types. But it is sometimes more difficult to detect mixtures on Marquis, because there sometimes is a tendency for heavy infection of type 4 to obscure that of type 2. Moreover, as pointed out previously, certain races that normally produce type 2 on Marquis may, under extremely favorable conditions, produce a type resembling 3 or 4. Occasionally mixtures may appear like type X, but the difference usually is apparent to anyone who has had considerable experience.

As it often is desired to learn not only which races are present in a collection but also the relative proportions of each, it is important first to inoculate with a random sample of the rust in collections. This

random distribution of inoculum is best attained by the brushing method described under "Inoculation Techniques." It usually is possible to determine the proportions easily by visual inspection. As an example, mixtures of races 17 and 56 have been common in the United States in recent years. The infection types follow:

	LC	Ma	Rel	Ko	Arn	Mnd	Spm	Kub	Ac	Enk	Ver	Kpl
Race 17	4	4-	0	3+	4=	4=	4=	3++	3++	3	1=	1=
Race 56	4	3+	3+	3+	1=	1=	1=	3+	3+	1=	1=	1-

It can be concluded that races 17 and 56 are present if the number of uredia on Reliance corresponds with the number of flecks or type-1 uredia on Arnautka, Mindum, Spelmar, and Einkorn, and if the number of type 3 or 4 uredia on Arnautka, Mindum and Spelmar corresponds with the number of similar uredia on Einkorn. It is then possible also to estimate the relative proportions of the two races in the collection.

The method of estimation and separation of races is described and illustrated more fully in "Physiologic Races of *Puccinia graminis* in the United States in 1939," by E. C. Stakman and W. Q. Loegering, U. S. Dept. Agr., Bur. Ent. and P. Q. E-522. The method is described in the next three paragraphs.

Figure 1 represents the results of inoculating the differential varieties of wheat with the rust as it was obtained from the field. There are two infection types on Marquis, types 4 and 2. Obviously, therefore, there are at least two races present. On Reliance there are type-4 pustules only, but the number is only about 33 percent of the total number of pustules on Marquis. On Arnautka, Mindum, Spelmar, and Einkorn the number of type-1 pustules corresponds with the total number of pustules on Reliance. It seems likely, therefore, that the race causing the large pustules on Reliance is causing the small ones on the three durums and Einkorn. It would seem that it might also be producing the type-2 pustules on Marquis, but knowledge of races makes this seem doubtful. The most likely combinations would be races 17, 19, and 56, but this is not certain. Therefore, inoculations were made as indicated in the diagram, and the results prove that this surmise was correct. In this case, then, three isolations were made: Isolate I proved to be pure race 19; isolate II was pure race 56; and isolate III contained both race 19 and race 17, the only difference being that 17 produces type-4 pustules on Marquis and 19 produces type-2.

It turns out, then, that three isolates were obtained from this collection of rust. In a given collection the number of isolates or isolations corresponds with the number of races identified. In the illustration chosen, for example, several other methods could have been used for arriving at the same result. A limited number of the differential varieties, known as a "half series," could have been inoculated with rust from the type-1 pustules on the three durums or Einkorn (after increasing the rust on a susceptible variety to obtain enough inoculum), but race 56

would have been identified from these isolations as it was when transfers were made from Reliance. Even though race 56 had been obtained in several series of isolations from one collection, it still would count as one isolate.

A "half series" is shown in figure 1 and includes the varieties Marquis, Reliance, Kota, Arnautka, Kubanka, and Einkorn. From long experience it has been found that Arnautka, Mindum, and Spelmar react alike to practically all the common races of stem rust, as do Kubanka and Acme. Therefore, after observing similar mixtures of type-4 and type-1 pustules on Arnautka, Mindum, and Spelmar, and complete susceptibility on Kubanka and Acme, it is sufficient to inoculate one variety from each group. Arnautka and Kubanka are commonly used for this purpose. In the case of Vernal and Khapli, which were completely resistant in the illustrations used, it must be concluded that these two varieties are resistant to all races in the mixture and need not be tested further. If either of these varieties shows a mixture of two infection types, then that particular variety must be included in the "half series." If there is doubt in any case concerning an identification made on the basis of a "half series," the isolate is tested on a complete series of differentials.

Table 1.--Differential varieties of *Triticum* spp. used in identifying physiologic races of *Puccinia graminis tritici*

<u><i>Triticum compactum</i></u>	<u><i>Triticum durum</i></u>
Little Club, C. I. ^a No. 4066 _b	Arnautka, C. I. No. 1493
	Mindum, C. I. No. 5296
<u><i>Triticum vulgare</i></u>	Spelmar, C. I. No. 6236
Marquis, C. I. No. 3641	Kubanka, C. I. No. 2094
Reliance, C. I. 7370 _b	Acme, C. I. No. 5284
Kota, C. I. No. 5878	
	<u><i>Triticum dicoccum</i></u>
<u><i>Triticum monococcum</i></u>	Vernal, C. I. No. 3686
Einkorn, C. I. 2433	Khapli, C. I. No. 4013

^a C. I. = Cereal Investigations accession number.

^b Certain lines of Jenkin, C. I. 5177, notably Hood, C. I. 11456, may be substituted for Little Club; and, generally, Kanred, C. I. 5146, for Reliance.

Table 2.--Infection types produced by physiologic races of Puccinia graminis tritici on differential varieties of Triticum spp.^a

- (0) IMMUNE--No uredia developed; hypersensitive flecks sometimes present and designated by a semicolon, thus, 0;
- (1) VERY RESISTANT--Uredia minute; surrounded by distinct necrotic areas
- (2) MODERATELY RESISTANT--Uredia small to medium; usually in green islands surrounded by a decidedly chlorotic or necrotic border
- (3) MODERATELY SUSCEPTIBLE--Uredia medium in size; coalescence infrequent; no necrosis, but chlorotic areas may be present, especially under unfavorable growing conditions
- (4) VERY SUSCEPTIBLE--Uredia large, and often coalescing; no necrosis, but chlorosis may be present under unfavorable growing conditions.
- (X) HETEROGENEOUS--Uredia variable, sometimes including all infection types and intergradations between them on the same leaf; no mechanical separation possible; on reinoculation small uredia may produce large ones, and vice versa

^a Plus and minus signs are used to indicate variation within a given type: ++ and = indicate the upper and lower limits, respectively, of each type. The symbol ± indicates a variation between + and - for the type.

Relation of infection types to rust-reaction classes
used in the analytical key, table 3

In the key, table 3, only three classes of rust reaction are used:

RESISTANT includes infection type 0, 1, and 2
MESOTHEtic includes infection type X
SUSCEPTIBLE includes infection types 3 and 4

Table 3.--Key for identifying physiologic races of Puccinia graminis tritici on the basis of their pathogenicity on 12 differential varieties of Triticum spp.

Reaction of differential varieties	Physiologic race (key number)	Races related to those designated in key, but not necessarily interrelated
Little Club resistant		
Marquis resistant		
Arnautka resistant.....	138	
Arnautka susceptible.....	130	
Marquis mesothetic.....	99	
Marquis susceptible		
Khapli resistant.....	131	
Khapli susceptible.....	41	
Little Club mesothetic		
Marquis resistant		
Kubanka resistant		
Einkorn resistant.....	103	111
Einkorn susceptible.....	160	102
Kubanka mesothetic.....	68	69
Kubanka susceptible.....	72	
Marquis mesothetic.....	58	121
Marquis susceptible		
Reliance resistant.....	161	21
Reliance susceptible.....	144	40
Little Club susceptible		
Marquis resistant		
Reliance resistant		
Kota resistant		
Arnautka resistant		
Kubanka resistant		
Acme resistant		
Einkorn resistant.....	111	47,50,70,71,103
Einkorn susceptible.....	102	104,112,160,167,180
Acme susceptible.....	2	48,59,73,162
Kubanka mesothetic		
Acme resistant		
Vernal resistant.....	180	102,112,166,167
Vernal mesothetic.....	167	102,180,182
Vernal susceptible.....	182	167,181
Acme mesothetic.....	50	47,111,139,186
Acme susceptible		
Einkorn resistant.....	139	50,186
Einkorn susceptible.....	59	2,23,48,73,162
Kubanka susceptible		
Acme resistant.....	166	180
Acme susceptible		
Einkorn resistant		
Vernal resistant.....	186	50,139
Vernal susceptible.....	27	
Einkorn susceptible		
Vernal resistant.....	23	59,118
Vernal susceptible.....	69	68

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Table 3, p. 2

Reaction of differential varieties	Key Race	Related races
Arnautka mesothetic		
Acme mesothetic.....47		16,50,111
Acme susceptible.....48		2,14,59,73,178
Arnautka susceptible		
Mindum resistant.....6	178	
Mindum mesothetic.....178		6,14,48
Mindum susceptible		
Kubanka resistant.....4		
Kubanka mesothetic.....45	53	
Kubanka susceptible		
Einkorn resistant.....16	47,81,94	
Einkorn susceptible		
Vernal resistant.....14	48,62,88,91,178	
Vernal susceptible.....53	45,119	
Kota susceptible		
Arnautka resistant		
Kubanka mesothetic		
Vernal resistant.....140	105,155	
Vernal susceptible.....65		
Kubanka susceptible.....145		
Arnautka susceptible		
Mindum resistant.....28		
Mindum susceptible		
Vernal resistant.....19	78,158	
Vernal susceptible.....123	120	
Reliance susceptible		
Kota resistant		
Arnautka resistant		
Kubanka resistant		
Acme resistant.....153		
Acme susceptible.....7	152,171,175	
Kubanka mesothetic		
Acme resistant.....66		
Acme susceptible		
Vernal resistant.....152	7,33,171,175	
Vernal mesothetic.....175	7,51,152	
Kubanka susceptible		
Vernal resistant.....33	152,172	
Vernal susceptible.....51	175	
Arnautka susceptible		
Mindum mesothetic		
Vernal resistant.....151	10	
Vernal susceptible.....89	83	
Mindum susceptible		
Einkorn resistant.....95		
Einkorn susceptible		
Vernal resistant.....10	96,151	
Vernal susceptible.....85	89	

Table 3, p. 3

Reaction of differential varieties	Key race	Related races
Kota susceptible		
Arnautka resistant		
Einkorn resistant.....173		
Einkorn susceptible		
Vernal resistant.....177		
Vernal susceptible.....109		
Arnautka mesothetic.....38	39	
Arnautka susceptible		
Mindum mesothetic.....174	98	
Mindum susceptible		
Einkorn resistant.....98	63,174	
Einkorn susceptible		
Vernal resistant.....39	38,179	
Vernal susceptible.....115		
Marquis mesothetic		
Reliance resistant		
Kota resistant		
Arnautka resistant		
Kubanka resistant		
Acme resistant		
Einkorn resistant		
Vernal resistant.....71	70,111	
Vernal mesothetic,,,,,70	71,111	
Einkorn susceptible.....104	102	
Acme susceptible.....185		
Kubanka mesothetic		
Vernal resistant.....112	43,102,180	
Vernal susceptible.....181	182	
Kubanka susceptible.....118	23,44	
Arnautka mesothetic.....165	119	
Arnautka susceptible		
Einkorn resistant		
Vernal resistant.....81	16,75,94	
Vernal susceptible.....169	184	
Einkorn susceptible		
Vernal resistant.....88	14,24,62,91	
Vernal susceptible.....119	57,117,165	
Kota mesothetic		
Arnautka resistant		
Kubanka mesothetic		
Acme resistant.....168		
Acme susceptible.....162	1,2,59,61	
Kubanka susceptible.....92	176	
Arnautka mesothetic.....73	2,17,37,48,59,78	
Arnautka susceptible		
Einkorn resistant.....94	16,21,81	
Einkorn susceptible.....91	9,14,85,88,120	
Kota susceptible		
Arnautka resistant		
Kubanka mesothetic		
Einkorn resistant.....185	80	
Einkorn susceptible		
Vernal resistant.....155	1,61,105,140	
Vernal mesothetic.....105	57,93,140,155	

Table 3, p. 4

Reaction of differential varieties	Key race	Related races
Kubanka susceptible		
Vernal resistant.....136		1,157
Vernal mesothetic.....157		57,136,154
Vernal susceptible.....154		57,157
Arnautka mesothetic.....149		9,30,76,85,120,150,156,158
Arnautka susceptible		
Mindum mesothetic.....156		9,120,149
Mindum susceptible		
Vernal resistant.....78		17,19,73,158
Vernal mesothetic.....158		9,19,78,120,149
Vernal susceptible.....120		9,91,123,149,156,158
Reliance mesothetic		
Arnautka mesothetic.....188		15
Arnautka susceptible.....62		11,14,88,96,114,179
Reliance susceptible		
Kota resistant		
Kubanka mesothetic.....171		7,35,74,152,172
Kubanka susceptible.....172		33,35,171
Kota mesothetic.....96		10,11,62,179
Kota susceptible		
Arnautka resistant.....84		82
Arnautka susceptible		
Mindum mesothetic		
Vernal resistant.....113		11,179
Vernal susceptible.....106		15,87
Mindum susceptible		
Einkorn resistant.....63		34,98
Einkorn susceptible.....179		11,39,62,96,113
Marquis susceptible		
Reliance resistant		
Kota resistant		
Arnautka resistant		
Mindum resistant		
Kubanka resistant		
Vernal resistant.....54		
Vernal susceptible.....134		
Kubanka mesothetic.....43	112	
Kubanka susceptible		
Einkorn resistant		
Vernal resistant.....135		
Vernal susceptible.....79		
Einkorn susceptible		
Vernal resistant.....44	118	
Vernal susceptible.....121	58	
Mindum susceptible.....132		
Arnautka susceptible		
Mindum resistant.....141	142	
Mindum mesothetic.....142	24,141	
Mindum susceptible		
Kubanka resistant.....46	55	
Kubanka mesothetic.....55	46,117	

Table 3, p. 5

Reaction of differential varieties	Key race	Related races
Kubanka susceptible		
Einkorn resistant		
Vernal resistant.....75		81
Vernal susceptible.....184		169
Einkorn susceptible		
Vernal resistant		
Khapli resistant.....24		88,142
Khapli susceptible.....42		
Vernal susceptible.....117		55,119
Kota mesothetic.....170		116
Kota susceptible		
Arnautka resistant		
Kubanka resistant.....60		49
Kubanka mesothetic		
Acme mesothetic		
Vernal resistant.....128		1,29,61,159
Vernal mesothetic.....150		57,93,124,128
Acme susceptible		
Einkorn resistant		
Vernal resistant.....49		60,176
Vernal susceptible.....80		183
Einkorn susceptible		
Vernal resistant.....61		1,128,155,162
Vernal susceptible.....93		57,105,159
Kubanka susceptible		
Acme mesothetic.....124		57,159
Acme susceptible		
Einkorn resistant.....176		49,92
Einkorn susceptible		
Vernal resistant.....1		61,128,136,155,162
Vernal susceptible.....57		93,105,124,154,157,159
Arnautka mesothetic		
Acme mesothetic		
Vernal resistant.....29		17,128
Vernal susceptible.....30		9,149
Acme susceptible.....76		9,85,149
Arnautka susceptible		
Mindum resistant.....26		
Mindum mesothetic		
Kubanka mesothetic.....90		21
Kubanka susceptible.....150		9,149
Mindum susceptible		
Kubanka resistant		
Vernal resistant.....5		37
Vernal susceptible.....8		
Kubanka mesothetic.....37		5,17,73
Kubanka susceptible		
Einkorn resistant		
Vernal resistant.....21		90,94,161
Vernal susceptible.....116		170
Einkorn susceptible		
Vernal resistant.....17		29,37,73,78,85,114

Table 3, p. 6

Reaction of differential varieties	Key race	Related races
Vernal mesothetic.....85		9,17,76,91,149
Vernal susceptible.....9		30,76,85,91,120,149,150, 156,158
Reliance mesothetic.....114		11,17,62
Reliance susceptible		
Kota resistant		
Arnautka resistant		
Mindum resistant		
Kubanka mesothetic		
Einkorn resistant.....64		
Einkorn susceptible		
Vernal resistant.....74		35,171
Vernal susceptible.....108		
Kubanka susceptible		
Acme resistant.....137		
Acme susceptible.....35		74,171,172
Mindum susceptible.....135		
Arnautka mesothetic.....51		122
Arnautka susceptible		
Mindum mesothetic.....86		
Mindum susceptible		
Einkorn resistant		
Vernal resistant.....107		
Vernal susceptible.....143		129
Einkorn susceptible.....122		31
Kota mesothetic		
Acme mesothetic.....163		15,110
Acme susceptible.....129		40,143
Kota susceptible		
Arnautka resistant		
Mindum resistant		
Kubanka resistant		
Einkorn resistant.....148		
Einkorn susceptible.....3		36
Kubanka mesothetic		
Acme mesothetic		
Einkorn resistant.....127		56,125,126
Einkorn susceptible		
Vernal resistant.....101		18,36
Vernal susceptible.....67		52
Acme susceptible		
Einkorn resistant		
Vernal resistant.....125		56,127,146
Vernal mesothetic.....146		97,125,147
Vernal susceptible.....97		146
Einkorn susceptible		
Vernal resistant.....36		3,18,82,101
Vernal mesothetic.....82		36,52,84
Vernal susceptible.....52		67,82
Kubanka susceptible		
Acme resistant.....20		
Acme mesothetic.....164		147

Table 3, p. 7

Reaction of differential varieties	Key race	Related races
Acme susceptible		
Einkorn resistant		
Vernal resistant.....56		125,127
Vernal susceptible....147		146,164
Einkorn susceptible.....18		36,101
Mindum susceptible		
Spelmar resistant.....25		
Spelmar susceptible.....22		
Arnautka mesothetic		
Einkorn resistant.....126		34,127
Einkorn susceptible.....32		11
Arnautka susceptible		
Mindum resistant.....12		
Mindum mesothetic.....87		15,106
Mindum susceptible		
Spelmar resistant.....187		
Spelmar susceptible		
Kubanka resistant.....13		
Kubanka susceptible		
Acme resistant.....100		
Acme susceptible		
Einkorn resistant		
Vernal resistant.....34		63,77,126
Vernal mesothetic....77		34,40
Vernal susceptible...40		77,129,144
Einkorn susceptible		
Vernal resistant.....11		32,62,96,110,113,114,179
Vernal mesothetic...110		11,15,163
Vernal susceptible		
Khapli resistant..15		87,106,110,163,188
Khapli susceptible		
...189		

Table 4.—Mean infection types produced by physiologic races of *Puccinia graminis tritici* on differential varieties of *Triticum* spp.

Physiologic race	Mean reaction of differential varieties											
	Little Club	Marquis	Reliance	Kota	Arnautka	Mindum	Spelmar	Kubanka	Acme	Ein Korn	Vernal	Khapli
1	4	4-	0	3+	1=	1	1=	3+	3++	3	0;	1=
2	4	2=	2=	2=	1-	1	1=	1+	3++	3+	1-	0;
3	4	4-	4=	3+	1=	1=	1-	1+	3++	3+	1=	0;
4	4+	2-	1-	2+	4=	3+	3++	2	3++	3++	1=	1=
5	4	4-	0;	3	4=	3++	3++	1++	3+	3	0;	0;
6	4	2	1=	0;	3+	2=	2=	1	3+	3	0;	0;
7	4	2=	3+	1=	1=	1++	1-	1	3++	3-	1	1-
8	4	4	0;	4-	4=	3++	4=	0;	3	3	4	0;
9	4	4-	0	3++	4-	4=	4=	4=	3++	3+	4+	1-
10	4+	2-	3++	2	4	4	4	3++	4-	3+	1=	1=
11	4-	4=	3++	3+	4=	4=	4=	3++	3++	3	1=	1=
12	4+	4-	4=	3+	4=	1	1++	1++	3++	3++	1=	0;
13	4	4-	3++	3++	4=	3++	3++	2-	3++	3	1	1=
14	4+	2-	1-	1++	3++	3++	3++	3++	3++	3	1=	0;
*15	4	4-	4=	3++	4=	4=	4=	3++	3++	3++	4+	1=
16	4-	2=	0	1	3++	3+	3++	3+	4=	1=	1=	1
17	4	4-	0;	3+	4=	4=	4=	3++	3++	3	1=	1=
18	4	4-	4=	3++	1	1=	1-	3++	3++	3+	1-	1+
19	4	2-	0;	3-	4=	4=	4=	3++	3++	3	0;	1=
20	4	4=	4=	4=	1++	1-	1++	3++	1++	3+	1=	1-
21	4	4	0	3++	4-	4-	4-	4=	3++	1=	0;	1=

Table 4, p. 2

Physiologic race	Mean reaction of differential varieties											
	Little Club	Marquis	Reliance	Kota	Arnautka	Mindum	Spelmar	Kubanka	Acme	Einkorn	Vernal	Khapli
22.....	4+	4+	4	3	1	4	4-	0;	3+	3	1-	0;
23.....	4	2	1-	1=	1	1=	1-	3+	3++	3	0;	0;
24.....	4	4=	0;	2=	4=	4=	4=	3++	3+	3+	1=	0;
25.....	4	4	3+	3	1-	3	1=	3	3++	3	1=	1-
26.....	4	4	0;	3	4-	1=	3++	1=	4=	3	1-	1+
27.....	4=	2	0	0;	1=	1	1-	4=	3++	1=	4+	1++
28.....	4	2	0;	3	4-	1	4=	3	3	3	1=	0;
29.....	4	4-	0	3	X++	X+	X+	X	X+	3	1-	1-
30.....	4	4	0;	3++	X++	X+	X+	X+	X++	3+	4=	1
31.....	4+	4	3++	2-	X-	X+	X+	X	X+	3+	1-	1
32.....	4	4=	4=	3+	X+	X+	X+	X-	X+	3	1=	1-
33.....	4+	2	4	1+	1=	1-	1	4=	3++	3	1-	1
34.....	4+	4-	4-	4=	4	4=	4=	4+	3++	1=	0;	1+
35.....	4	4=	3+	0;	1=	1-	1=	3+	3++	3	0;	1
36.....	4	4	4-	3++	1=	1=	0;	X	3++	3+	0;	1-
37.....	4	4-	0	3++	4=	4=	4=	X+	3+	3	1=	1-
38.....	4	2=	4-	3-	X+	X+	X+	X+	X++	4-	1=	1+
39.....	4-	2=	4=	3+	4+	3++	4-	4=	3++	4=	1=	1-
40.....	4+	4+	4	4+	4+	4+	4	4=	4	0;	4=	1=
41.....	2++	4	0	0;	4=	4	4+	4+	4-	4-	1-	4 ^c
42.....	4	4	1+	0;	4+	4	4	4	4	4=	2=	4 ^c
43.....	4	3++	0	0;	0;	0;	0;	X	1	3	1	0;
44.....	4	3++	0	0;	0;	0;	0;	3+	3+	3	1	0;
45.....	4	2	0	2-	4	4	4	X	X	3	3	1

Table 4, p. 3

Physiologic race	Mean reaction of differential varieties											
	Little Club	Marquis	Reliance	Kota	Arnautka	Mindum	Spelmar	Kubanka	Acme	Einkorn	Vernal	Khapli
46.....	4	3++	0	2-	4	4	4	1	1	3	3	1
47.....	4	2-	0	1+	X-	X;	X++	X;	X+	1=	0;	1=
48.....	4+	1	0;	1+	X+	X=	X+	X+	4-	4=	1=	1+
49.....	4	4-	0	4=	1=	1-	0;	X=	3+	1-	0;	1=
50.....	4+	2+	0;	2++	1-	0;	0;	X=	X+	0;	0;	0;
51.....	4	2=	3+	0;	0;	0;	0;	4	3++	3+	4-	0;
52.....	4	4	4-	4	1=	1=	1=	X+	4	4-	4+	1-
* 53.....	4	2+	0	1	4	4	4	4	4	3+	3+	1
54.....	4	3++	0	0;	0;	0;	0;	1	3+	3	1	0;
55.....	4	4	0	2-	4	4	4	X	X	3	3	1
56.....	4	3+	3+	3+	1=	1=	1=	3+	3+	1=	1=	1-
57.....	4	4-	0;	3+	1	1	1	4	3+	3	3	1
58.....	X+	X+	0	0;	1+	1=	1+	4+	3+	3++	4+	1++
* 59.....	4+	2+	0	0;	1=	1=	1-	X-	3++	3+	1=	0;
60.....	4++	4++	0;	3++	0;	0;	0;	0;	3+	1+	0;	1=
61.....	4+	4	0	3+	0;	0;	0;	X	4+	4	0;	0;
62.....	4	X+	X+	X	4	4	4	4	4	3++	0;	1-
63.....	4+	X++	4	3++	4+	4++	4+	4+	4 ⁿ⁺	1=	1=	0;
64.....	4++	4+	3++	1+	1=	0;	1=	X+	3 ^{c+}	1=	0;	1
65.....	4	2	0	3	0;	0;	0;	X	4	4	4	1
66.....	4	2	4	0;	0;	0;	0;	X+	1=	3	0	0
67.....	4+	4+	4	4	1+	2=	2=	X=	X+	3-	4+	1-
68.....	X+	2+	0	0;	1=	1+	1-	X++	4+	4	4++	0;
* 69.....	3++	2+	0;	0;	0;	0;	0;	3+	4=	3	3++	1=

Table 4, p. 4

Physiologic race	Mean reaction of differential varieties											
	Little Club	Marquis	Reliance	Kota	Arnautka	Mindum	Spelmar	Kubanka	Acme	Einkov'n	Vernal	Khapli
70.....	4+	X+	0;	0;	0;	0;	0;	0;	0	1=	X+	0;
71.....	4+	X-	0	0;	0;	1=	0;	1=	0;	0;	0;	0;
72.....	X-	2	0;	0;	1+	1+	1+	4+	4+	3+	3+	X
73.....	4	X	0	X	X	X	X	X	3+	4-	1	1
74.....	4	4-	3=	2+	0;	0;	0;	X-	3+	3+	0;	1
75.....	4	3+	2+	0;	3+	3+	3+	4-	3+	1	0;	1
76.....	4	4-	0	3+	X	X	X	X	3+	3+	X-	1
77.....	4	4	3=	3-	3 ^c	3 ^c	3 ^c	4-	3+	1+	X	1
78.....	4	X	0	3=	3 ^c	3 ^c	3 ^c	3+	3+	3+	1	1
79.....	4	4-	0	1-	1-	1-	1-	4-	3+	0;	3+	1
80.....	4	3 ^c	0	3-	0;	0;	0;	X-	3+	1-	3+	1
81.....	4	X	0	1+	4	4	4	4	4-	1-	1-	1-
82.....	4	3+	3+	3+	0;	0;	0;	X	3+	3+	X	1
83.....	4	1+	3-	1-	3+	3+	3+	3+	3+	3+	3+	1
84.....	4	X	3 ^c	3-	0;	0;	0;	X	4	3+	X	1
85.....	4	4-	0	3+	4-	4	4	4	4	3+	X	1
86.....	4	3+	3+	1+	3+	X	X	X	3+	3+	3+	1
87.....	4	4	4	3+	4	X	X	X	3+	3+	4	1
88.....	4	X	0	1+	4	4	4	4	4	3+	1	1
89.....	4	2	3+	0;	4	X	X	X	3+	3+	3+	1
90.....	4	4	0	3+	4	X	X	X	3+	1	1	1
91.....	4	X	0	X	4	4	4	4-	3+	3+	X	1
92.....	4	X	0	X	1	1	1	4	4	1	1	1
93.....	4	3+	0	3=	0;	0;	0;	X	3+	3+	3+	1

Table 4, p. 5

Physiologic race	Mean reaction of differential varieties											
	Little Club	Marquis	Reliance	Kota	Arnautka	Mindum	Spelmer	Kubanka	Acme	Einkorn	Vernal	Khapli
94.....	4	X	0	X	4-	4-	4-	4-	3+	1	1	1
95.....	4	2	3+	0;	4	4	4	4	3+	1	1	1
96.....	4	X	4	X	4	4	4	4	3+	3+	1	1
97.....	4	3+	4	3+	0;	0;	0;	X	3	0;	3+	1
98.....	4	2=	4+	3+	4-	3++	3	4=	3-	1+	1	1-
99.....	1+	X	3++	3	0;	2+	2++	4+	2+	2+	3++	3++
100.....	3+	4	3+	3=	3	3-	3=	4=	1	1+	X+	1
101.....	4+	4++	4-	4+	1	0;	0;	X+	X-	3	0;	1+
102.....	4+	0;	1+	0;	0;	0;	1=	1=	0;	3+	0;	1=
103.....	X++	0	0;	0	0	0;	0;	0;	0;	2-	1=	0;
104.....	4	X=	0	0;	0;	0;	0;	0;	0;	3+	X+	0;
105.....	4	X-	0	3+	0;	0;	0;	X-	3+	3	X	1=
106.....	4	X	3	3-	4	X	X	X	3	3+	4-	1-
107.....	4	3+ ^c	3-	0;	4	4	4	4	3	1-	0;	1-
108.....	4	4	4-	0;	1+	0;	0;	X+	4-	3	3+	1-
109.....	4	2+	4	3-	1+	1+	1+	4	3-	3+	4	1
110.....	4	4-	3	3-	3+	3+	3+	3+	3+	3	X-	1
111.....	3+ ^c	1-	0	0;	0;	0;	0;	0;	0;	1-	0;	1-
112.....	4	X	0	0;	0;	0;	0;	X-	0;	3	0;	1-
113.....	4	X	3=	3+	3+	X-	X-	X-	4	3+	0;	1
114.....	4	3+	X	3+	4	4	4	4	4-	3+	1-	1
115.....	4	2-	3=	3=	4-	4-	4	4-	4-	3+	3+	1-
116.....	4	4-	0	3	4	4	4	4	4-	1	4-	1-
117.....	4	4-	0	0;	4-	4-	4-	4-	4	3+	3+	1-

Table 4, p. 6

Physiologic races	Mean reaction of differential varieties											
	Little Club	Marquis	Reliance	Kota	Arnautka	Mindum	Spelmar	Kubanka	Acme	Einkorn	Vernal	Khapli
118.....	4	X	0	1-	1-	1-	1-	4	4	3+	1-	1-
119.....	4	X	0	0;	4	4	4	4	4-	3+	3+	1-
120.....	4	X	0	3=	4	4	4	4	4-	3+	3	1-
121.....	4	4-	0	0;	1-	1-	1-	4	3+	3	3+	1
122.....	4-	3+	4-	0;	4	4	4	4	4-	3+	1-	1
123.....	4	2-	0	3-	3+	4-	4	4	4-	3+	3+	1
124.....	4	3 ^{-c}	0	3 ^{=c}	0;	0;	1=	3+	X	3	X-	1
125.....	4 ₊	4	4	4	0;	0;	0;	X	4	1=	0;	1-
126.....	4=	4=	3+	3+	X ₊	X++	X+	X-	X	1 ₊	1=	1-
127.....	4-	4-	3++	3+	1=	1 ₊	1=	X	X	0;	0;	1-
128.....	4	3++	0;	3 ₊	1-	1=	1	X-	X ₊	3 ₊	1=	1-
129.....	4	4	4	X	4	4	4	4	4	1-	4	0
130.....	1-	2	0	0	4	4	4	4	4	3+	0	1-
131.....	1-	4	0	0	4	4	4	4	4	4+	1	1-
132.....	4	4	0	2	1	4	4	1	4	1	1	1
133.....	4	4	0	0	1	2	2	4	4	0	1	2
134.....	4	4	0	0;	0;	0;	0;	1	3	3	3	1
135.....	4	4	4	0;	0;	3	2	4	3	1	1	1
136.....	4	X	0	3=	0;	0;	0;	4-	4	4-	1-	1
137.....	4	4-	4-	0;	1-	1-	1-	3	1-	3-	X-	1
138.....	2	0;	0	0;	0;	0;	0;	0;	0;	1+	X-	0;
139.....	4 ₊	2+	1-	2 ₊	1-	1=	1	X	4+	1=	1-	0;

Table 4, p. 7

Physiologic race	Mean reaction of differential varieties											
	Little Club	Marquis	Reliance	Kota	Arnautka	Mindum	Spelmar	Kubanka	Acme	Einkorn	Vernal	Khapli
140.....	4+	2-	1	4=	1+	0;	1+	X+	4+	4-	1+	1+
141.....	4	4	1+	0	4	1-	4	1+	4	4	1-	1+
142.....	4	4-	2	0	3++	X	4	X+	4	4	1	1++
143.....	4	4-	4-	0	4-	4-	4-	4-	3++	2	3++	1=
144.....	X	4	4	5+	4-	4-	4-	4-	3++	1+	3++	1++
145.....	4	0	2	4	0;	0;	0;	4	4	0;	4	2
146.....	4+	4	4+	3++	1-	1+	1=	X+	3++	1=	X+	1+
147.....	4++	4+	4	4+	1=	1-	1	4+	4	1=	4+	1+
148.....	4	3+	3+	3+	1-	0;	0;	0;	3+	1-	0;	1-
149.....	4	X+	0	3-	X+	X	X	X	X	X	X	1-
150.....	4	3-	0	5-	3+	X	X	4-	X	3+	3+	1-
151.....	4	1	3-	0;	4-	X	X	X	4-	3+	0;	1-
152.....	4	1+	3-	0;	1	0;	0;	X-	3+	3+	0;	1-
153.....	4-	1+	3	0;	0;	0	0	0;	0	0;	X-	0;
154.....	4	X	0	3=	1	0;	0;	4	4	3+	4-	1
155.....	4	X	0	3=	1	0;	0;	X	4	3+	0;	1
156.....	4	X	0	3=	4	X	X+	3+	4-	3+	4-	1
157.....	4	X	0	3=	1-	0;	0;	4	4	3+	X	1-
158.....	4	X	0	3=	4	4-	4-	4-	4-	3+	X	1
159.....	4-	4	0	3++	1	1=	1=	X++	X	4=	X+	1
160.....	X+	0;	0	0;	0;	0;	0;	1+	0	3+	1	0;
161.....	X	4	0	3++	4=	4-	4-	4=	3++	1=	0;	0;
162.....	4	X+	0;	X-	0;	0;	0;	X	3	3	0;	1

Table 4, p. 8

Physiologic race	Mean reaction of differential varieties											
	Little Club	Marquis	Reliance	Kota	Arnautka	Mindum	Spelmar	Kubanka	Acme	Einkorn	Vernal	Khapli
163	4-	4=	4-	X	4-	4	4	4-	X	3++	X+	1=
164	4	4-	4=	3+	0;	0;	0;	3++	X=	1-	3+	0;
165	4	X+	2	0;	X-	X-	X=	X+	X=	3	4-	1+
166	4-	1++	2+	0;	1=	0;	0;	4-	0;	3+	1=	1-
167	4	2-	2++	1-	0;	0;	0;	X	0;	3++	X	1
168	4	X	0	X	0;	0;	0;	X	0;	3	3+	1=
169	4	X	0	0	4	4	4	4	4	0;	3+	1
170	4	4	1	X	4	4	4	4	4	0;	4	1
171	4	X+	3-	0;	1	0;	0;	X-	3+	3+	0;	1-
172	4	X	3-	2-	1-	0;	0;	4-	4	3	0;	1-
173	4	2	4-	3-	0;	0;	0;	4	4-	1-	0;	1
174	4	2	4-	3=	4-	X	X	4-	4-	1-	0;	1
175	4	2+	4	1+	1-	0;	0;	X	4-	3+	X	1-
176	4	4	0	4-	1-	1-	1-	4	4-	1	0;	1-
177	4	2	4-	3-	1-	1-	1-	4-	3+	3	0;	1-
178	4	1	0;	0;	4	X-	X	X+	4	3+	0;	1
179	4	X	4	4-	4	4	4	4	4-	3+	1-	1-
180	4+	2=	0;	1=	1+	1=	1-	X+	1=	3+	0;	1+
181	4	X+	0;	0;	0;	0;	0;	X	1-	3+	3+	0;
182	4-	2++	2+	0;	1++	1+	1	X+	1	3	3	1+
183	4	X	0	3=	1-	0;	0;	X	4-	1-	4-	1-
184	4	3	0	0;	3	3	3-	4=	4	1	4	1
185	4	X-	0	0;	1=	0;	1=	1=	4	1=	0;	1

Table 4, p. 9

Physiologic race	Mean reaction of differential varieties											
	Little Club	Marquis	Reliance	Kota	Arnautka	Mindum	Spelmar	Kubanka	Acme	Einkorn	Vernal	Khapli
186....	4	1	0	0;	1	0;	0;	4=	4=	1	0;	1
187....	4	4	3	3	4-	3++	2	1++	1++	0	2	1
188....	4	X+	X ₊	X ₊	X++	X++	X+	X+	X ₊	3+	3++	1 ₊
189....	4	4	4	3+	4	4	4	4	4	4	4	4 ^c

* Infection types given in table 4 are produced by biotypes most frequently encountered up to the present. There may be some deviation from the recorded types when other closely related biotypes are encountered. The following are the most important examples:

Race 15A has a tendency to produce weaker infection than is represented by infection types recorded in the table; biotype B has a tendency to produce heavier infection than those recorded.

Race 53A has a tendency to produce type 2= on Reliance, and there is a tendency toward the production of type X on Arnautka, Mindum, and Spelmar. This biotype may eventually be described as an independent race, depending on the results of thorough studies of the type-X infection.

Race 59A produces type 2 on Marquis and Reliance. Race 59B has a tendency to produce type 2+ on Marquis and type 2 on Reliance and on Kota.

Race 69A has a tendency to produce type X on Kubanka. Race 69B produces type 2 on Kota and type X on Kubanka. These two biotypes may eventually be described as a new race on the basis of the X reaction on Kubanka.

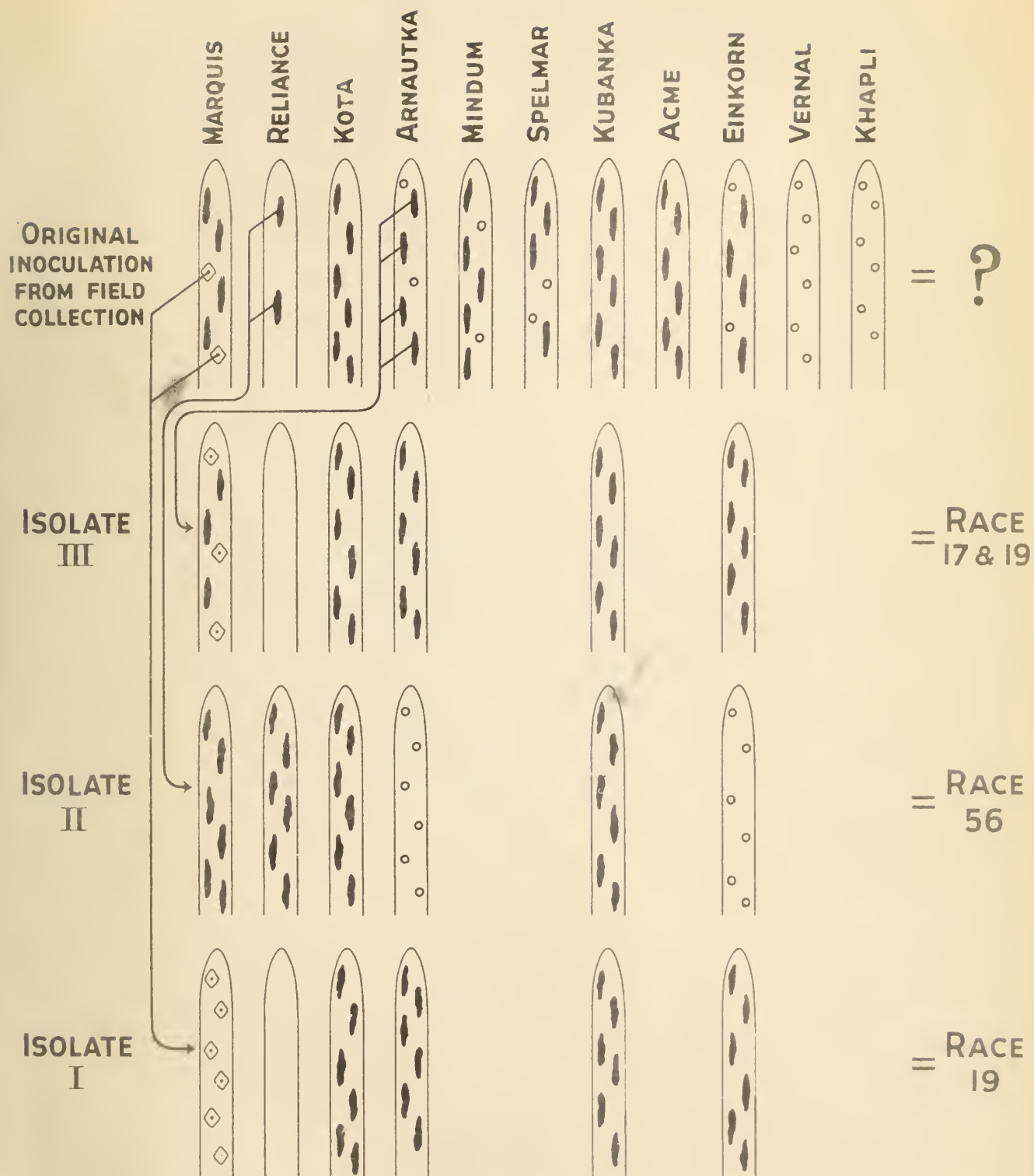


FIGURE 1. DIAGRAM SHOWING METHOD OF ISOLATING RACES FROM A MIXED FIELD COLLECTION

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